AN ABSTRACT OF THE THESIS OF

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Abstract approved:

Throughout North America, shorebird numbers have declined within the last several years. The loss of habitat is one of the major reasons for this decline. Habitat loss is not only occurring at northern breeding grounds and southern wintering grounds, but also along the migration route. Shorebirds may migrate thousands of kilometers between southern wintering grounds and northern breeding grounds. Along their migration route, shorebirds must stop periodically to replenish fat reserves. Loss or degradation of these stopover sites poses a serious threat to shorebird populations.

Kansas lies within the central flyway, which is one of the four major flyways through North America. Although Kansas has lost a large amount of its wetlands, there are two wetlands in the central part of the state that are used extensively by migrating shorebirds (Cheyenne Bottoms and

Quivira National Wildlife Refuge). Additional wetland areas are needed and the McPherson Valley Wetlands, also located in central Kansas, could be one such area. The area was recently purchased by the Kansas Department of Wildlife and Parks. As shorebird use of the area is relatively unknown, the purpose of my study was to determine if shorebirds use the area. Data were collected between April 1993 and October 1994.

Shorebirds did use the wetland and the usage appeared to be related to water levels. The water levels differed greatly between 1993 and 1994, as did shorebird numbers. Shorebirds did not appear to use all three sample sites proportionately. In addition, shorebird use seemed to be positively correlated with percent bare ground.

Shorebird Usage of a Reclaimed Wetland on the Central Great Plains

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INTRODUCTION

Shorebird numbers have declined throughout North America in the past ten to twenty years (Pfister et al., 1992; Neill, 1992). One of the suspected reasons for this decline is the loss of suitable habitats for wintering, breeding or migratory stopover sites (Helmers, 1992). The prime habitat for shorebirds is an area where the water table is at or near the soil surface or where the land is covered by shallow water (Helmers, 1992). Habitat modification is the most serious problem confronting shorebirds (Senner and Howe, 1984). An estimated 48 million wetland hectares have been lost between 1780 and 1980 and the remaining wetlands are fragmented or isolated (Kent, 1994). The combined loss of coastal and interior wetlands may exceed 40% nationally (Myers et al., 1987), and since 1950, it is estimated that Kansas has lost nearly 48-50% of its wetland areas (Zimmerman, 1990; Mitsch and Gosselink, 1993). The majority of these areas lost were marshy, shallow water habitats.

The life history of shorebirds makes them extremely susceptible to habitat loss. Migrating shorebirds may travel hundreds or even thousands of kilometers between stopover sites, causing them to spend a great deal of their lifetime migrating between northern breeding grounds and southern wintering grounds (Zimmerman, 1990; Evans et al., 1991). During migration, the accumulation of fat reserves is probably the most important use of stopover sites. Along their migration routes they must stop periodically and feed intensively to regain needed fat for the next segment of the flight. The amount of fat accumulated appears to be related to the distance of the subsequent flight (Morrison, 1984). Because shorebirds typically have low reproductive rates and high adult survivorship rates, populations of shorebirds are adversely affected by factors that decrease survivorship along the migration route (Myers et al., 1987). Stopover sites are a necessity during migration if the birds are to complete their life cycle.

There are four major flyways in North America used during shorebird migration. One flyway follows the west coastline of the United States, another follows the east coastline, the third route is the central flyway and the fourth follows the Mississippi River Valley (Zimmerman, 1990). During their lifetime, shorebirds often use different flyways such that many species take a more central route during northward migration than during southward migration (Morrison, 1984). This may be a response to food availability and climate (Harrington and Morrison, 1979). One of the major stopover sites in the central flyway is Cheyenne Bottoms (Morrison, 1984; Zimmerman, 1990). An additional area used heavily by shorebirds along the central flyway is Quivira National Wildlife Refuge (QNWR). Both areas are located in central Kansas and may be used by 10,000 shorebirds a year (Skagen and Knopf, 1994).

The McPherson Valley Wetlands are within 80 kilometers of Cheyenne Bottoms and QNWR, which are both used by large numbers of shorebirds during migration (Senner and Martinez, 1982; Zimmerman, 1990; Smith et al., 1991; Skagen and Knopf, 1994). The yearly status of wetlands in central and western Kansas is uncertain. These areas are subject to drying out due to drought, center pivot irrigation and the natural process of dry down (Zimmerman, 1990). Other wetland areas should be established to provide a variety of sites over a wider area. This would provide a redundancy in the system such that if one area is adversely affected, birds are able to go to other areas. The McPherson Valley Wetlands may prove to be a suitable additional stopover site for migration.

It is still uncertain how shorebirds choose stopover sites. Senner and Howe (1984) suggest many traditional stopover sites may provide more predictable feeding and roosting areas than other sites during migration, thus shorebirds would be expected to use these sites year after year. However, Skagen and Knopf (1994) suggest shorebirds use the interior wetlands opportunistically during migration. This would imply that if one site was inappropriate for any reason, shorebirds would use an alternative site. Thus, conservation of alternative sites along with traditional sites could be vital to shorebird survival.

The purpose of my study was to provide information on shorebird use at the McPherson Valley Wetlands. It was my intention to determine shorebird use of the wetland and the characteristics of the areas predominately used. Because the area had recently been acquired by the Kansas Department of Wildlife and Parks (KDWP), little or no restoration procedures or management occurred during the study. As this area will be undergoing major changes that will hopefully enable the regaining of its wetland potential, it is important to establish baseline data that can be used for comparisons in future years. Further, my data will make it possible to record how shorebirds react to these changes. I hypothesized that shorebirds would use the area and their usage would be related to water levels at the wetlands. In addition, I hypothesized that shorebirds use of each site would be equally proportional to the size of the site.

SITE DESCRIPTION

The McPherson Valley Wetlands are located within McPherson County, in central Kansas. The study area was located near the headquarters of the McPherson Valley Wetlands, about five kilometers west of the town of McPherson. The wetland complex was located about 80 kilometers east of Cheyenne Bottoms and QNWR. Shorebirds flying through the central part of the state could stopover at the McPherson Valley Wetlands as well as Cheyenne Bottoms and QNWR.

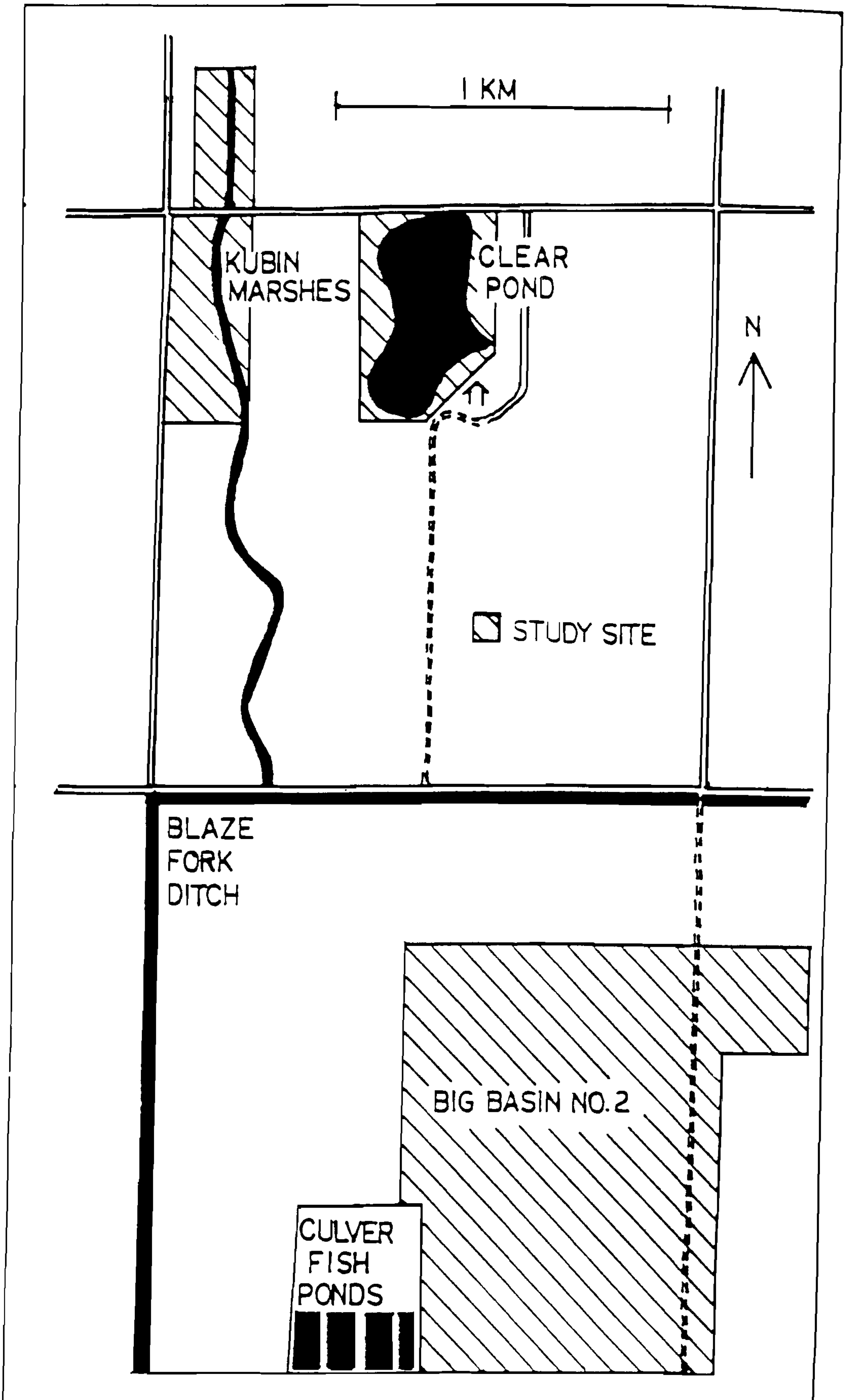
The wetlands of the McPherson Valley were historically a vast wetland complex heavily used by migrating waterfowl (Wilson, 1992). In the early 1900's the area was drained for farming. Until purchased by KDWP, the area was used for crop production, and there is still evidence of farming practices.

Surrounding the headquarters were three main wetland sites (Fig. 1). First, immediately to the northwest of the headquarters is Clear Pond. The water was approximately 0.5 to 0.75 meters deep with little or no vegetation growing in the water. The drainage basin of Clear Pond was cropland. Except for a small portion of the southeast corner of the pond, the pond lacked a shoreline suitable for shorebird use, as the edge of the soil dropped off dramatically at the water's edge. The pond often had significant wave action, due to the wind. This is the only site in the wetlands that KDWP has the opportunity to maintain water levels by filling the pond with ground water.

Second, about 0.8 kilometers to the west of the headquarters were the Kubin Marshes. This area included a wetland dominated by switchgrass (Panicum virgatum) in the north and a ditch that ran north and south through the area. South of the switchgrass wetland, the ditch ran through cropland. During the study period, wheat and grain sorghum were planted in the area. Overall, the Kubin Marshes appeared to offer little suitable habitat for shorebirds. The edges of the ditch and possibly some sparse portions within the switchgrass wetland were the only apparent suitable habitat for shorebird use.

Third, the Big Basin #2 lies 1.6 kilometers south of the headquarters. This site was large and flat. Because the entire site is not currently owned by KDWP, the land use practices differed throughout the Big Basin #2, which increased habitat heterogeneity and does not allow KDWP to maintain water levels. Private lands included the Culver Fish Ponds, a private wetland, and cropland. During the study, wheat, corn and grain sorghum were grown in the basin. Public land was in the conservation reserve program, planted with wheat, or was in early successional stages. Aside from the addition of a water control structure at the extreme southeast corner of Big Basin #2 adjacent to the Culver Fish Ponds, the land owned by KDWP had undergone little manipulation. Big Basin #2 was surrounded by a series of drainage ditches that ultimately drain the site into the Blaze Fork Ditch. This site appeared to have a large amount of suitable habitats available for shorebird use. The vegetation in the early successional portion of the site was fairly sparse. When the site was wet, most of the Big Basin #2 had from zero (moist soil) to 20 cm of water. Part of the ditch and the pool at the water control structure had deeper water than the rest of the site, which increased habitat available for use by many different migrating shorebirds.

Figure 1. Map of the study area, McPherson Valley Wetlands, in McPherson County, Kansas.


1 KM
KUBIN MARSHES
CLEAR POND
N
STUDY SITE
BLAZE FORK DITCH
BIG BASIN NO. 2
CULVER FISH PONDS

MATERIALS AND METHODS

For my study, I censused the spring and fall migration for 1993 and 1994. I followed the guidelines established by the International Shorebird Survey (ISS) in that censuses were conducted once every ten days between April 1 and June 10 and between July 11 and October 31 (Howe et al., 1989). The three sites censused were Clear Pond, Kubin Marshes and Big Basin #2. The sample site size for Big Basin #2 was approximately 113.4 hectares, while both Clear Pond and the Kubin Marshes areas were about 32.4 hectares each. Clear Pond and the Kubin Marshes were censused from the road by vehicle, but a minor rainfall would leave the basin inaccessible by vehicle and I would have to conduct my censuses on foot. The sites sampled at Clear Pond were the edge of the pond, the southeast corner with the mildly sloping bank and a small section directly across the road. Only the site along and in the ditch was sampled at Kubin Marshes.

At all times, I attempted to count all shorebirds along with all waders, terns and gulls, but if that was impossible, I estimated the number. I attempted to identify all birds to species. If I could not identify to species, the birds were identified to genus such as Dowitchers (Limnodromus), Yellowlegs (Tringa) and Peeps (Calidris). Sites where the birds were seen were also noted as follows: Clear Pond, Kubin Marshes, Big Basin #2 and other. The other category was used when the birds were seen around the census sites, but not within them, for example, Culver Fish Ponds. Birds were identified with the use of a spotting scope or binoculars. All censuses were conducted between sunrise and 1000.

Shorebird numbers and number of species were determined for each season. A Chi-square test was used to determine if shorebirds use of each site was equally proportional to the size of the sites (Zar, 1984).

Water levels were taken at Kubin Marshes and Big Basin #2. The measurements were taken off the bridge at the Kubin Marshes. The water level was taken at the water control structure at the south edge of Big Basin #2. The total centimeters, as taken from the top of the structure (bridge or water control structure) to the surface of the water were subtracted from the total length from the top of the structure to the soil surface to determine an approximate depth of the water. These water levels were taken during every census, with a few exceptions. Only Big Basin #2 water level values were used in the data analysis. Regression analysis was used to determine if any relationship existed between the number of shorebirds and the depth of the water (Zar, 1984).

Using a meter frame, I sampled vegetation once a season (Smith, 1990). Within Big Basin #2, pylons were placed for use by nesting Canada Geese (Branta canadensis). I used these pylons as starting points for the vegetation surveys. I ran a 100-meter tape from the structure for sampling purposes. Transects were run in three different directions (0, 120, and 240 degrees). Along the tape, I sampled every 20 meters (10, 30, 50, 70, and 90 meters). I placed the frame in position and allowed the spikes to fall to the ground. I then recorded whether the spike hit litter, bare or vegetated ground. I also recorded what vegetation, if any, hit the spike. Samples of the vegetation were collected for identification. Percent bare ground and vegetation types were calculated. Linear regression was used to examine the relationship between percent bare ground and number of shorebirds (Zar, 1984).

RESULTS

A total of 1064 shorebirds, comprising at least 20 different species, was seen during the sample periods (Table 1). Unknown peeps (Calidris spp.) accounted for the largest number of birds seen followed by Killdeer. Scientific names for each bird can be found in Appendix 2. A large number of shorebirds were observed in May, for both years (Fig. 2). A total of 685 other water birds, including herons, egrets, terns and gulls, comprising eleven different species were observed during the sampling season (Appendix 1).

The majority of shorebirds were seen in Big Basin #2 (Table 2). This is not surprising because Big Basin #2 is nearly 3.5 times larger than the other sites. Because of the difference in sizes of the three sites, a proportion of birds expected at each site was calculated. Chi-square analysis showed that shorebirds did not use each area proportionately. Considerably more shorebirds used the Big Basin #2 in the fall for both years than expected, while fewer birds used Clear Pond and the Kubin Marshes than expected ($X^2 = 113.59$, df = 2, $P < 0.001$). Considerably fewer shorebirds were seen at the Kubin Marshes during the spring seasons than expected, while larger numbers of shorebirds were seen at Clear Pond, and to a lesser extent Big Basin #2, than were expected ($X^2 = 141.61$, df = 2, $P < 0.001$).

Water levels varied greatly between the two years, with 1993 considered to be a wet year and 1994 considered to be a dry year. Big Basin #2 water levels revealed this difference (Fig. 4). Throughout most of 1994, the water level was at least 20 cm lower than in 1993. There was no significant relationship between the number of shorebirds and the water level in 1993 ($r^2 = 0.067$, df = 13, $P = 0.371$) (Fig. 5). Regression analysis showed a slight relationship between the water level and the number of shorebirds in 1994 ($r^2 = 0.405$, df = 16, $p = 0.006$). During a dry year, higher water levels improved shorebird usage. A similar relationship may have been present in 1993, if not for the over abundance of water in June. The water levels at that time left most of the area too deep for shorebird use.

Percent bare ground and percent litter did not differ greatly between the two years (Table 3). The relationship between the number of shorebirds and percent bare ground, is not significant ($r^2 = 0.262$, df = 3, $P = 0.488$) (Fig. 6).

The vegetation had representatives of grasses, forbs and sedges (Appendix 3).

Table 1. Numbers of shorebirds seen per season at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

SPECIES	SPRING 1993	FALL 1993	SPRING 1994	FALL 1994	TOTAL
Unknown Peeps	109	64	98	1	272
Killdeer	51	106	35	14	206
Lesser Yellowlegs	5	96	6	3	110
Dowitchers	16	41	34	0	91
Yellowlegs	60	11	10	0	81
Greater Yellowlegs	7	38	35	0	80
Baird's Sandpiper	61	0	16	0	77
Wilson's Phalarope	31	2	28	0	61
Semipalmated Sandpiper	3	3	16	0	22
Least Sandpiper	7	1	8	0	16
Spotted Sandpiper	2	7	0	0	9
Upland Sandpiper	0	3	3	2	8
Pectoral Sandpiper	4	3	0	0	7
Hudsonian Godwit	0	0	6	0	6
Western Sandpiper	0	0	6	0	6
American Avocet	0	3	0	0	3
Solitary Sandpiper	0	1	2	0	3
Dunlin	0	2	0	0	2
Common Snipe	1	0	0	0	1
Long-billed Curlew	1	0	0	0	1
Stilt Sandpiper	1	0	0	0	1
Willet	0	1	0	0	1
TOTAL	359	382	303	20	1064

Figure 2. Number of shorebirds seen per census at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

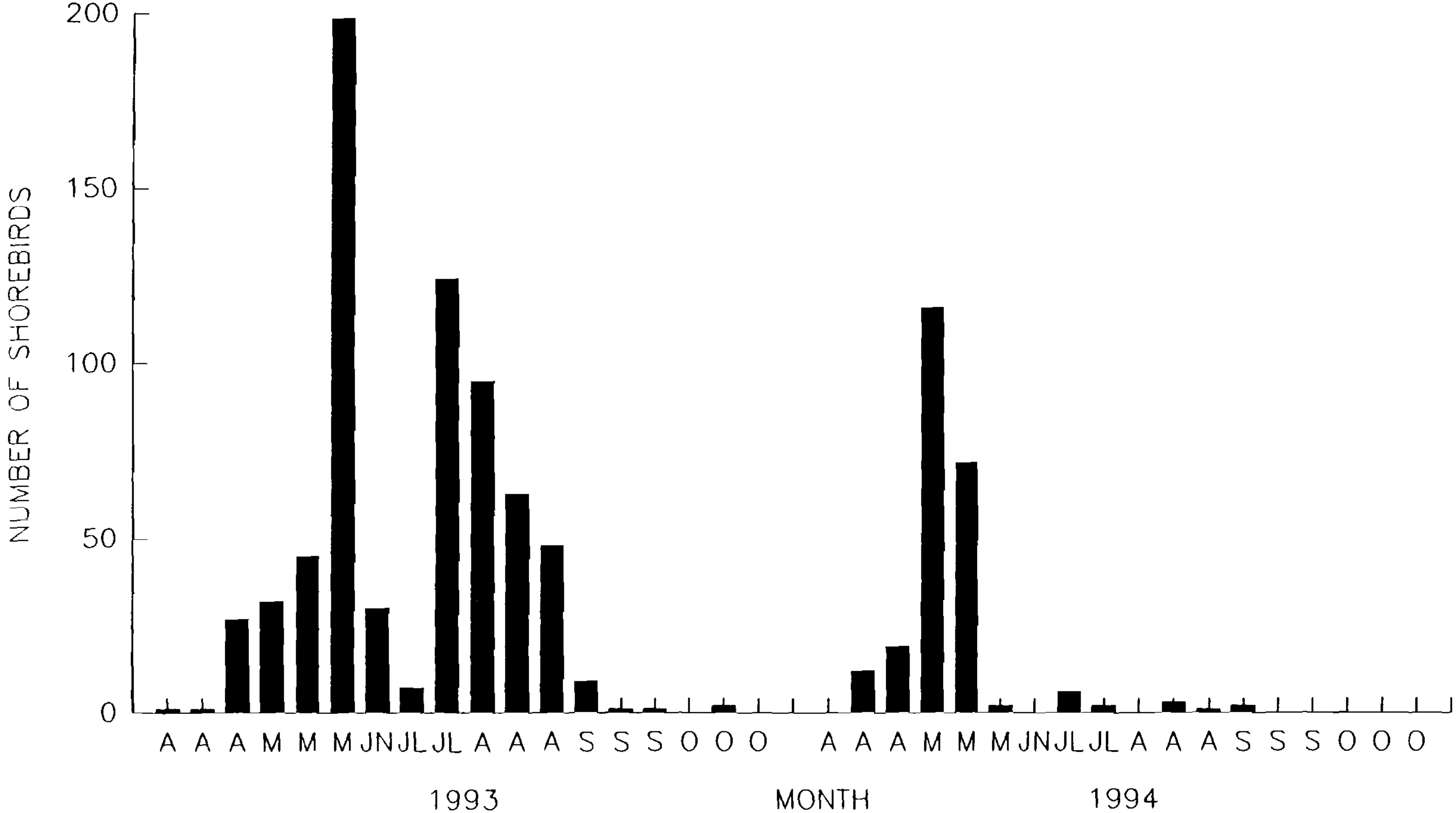

200
150
100
50
0
NUMBER OF SHOREBIRDS
A A A M M M JN JL JL A A A S S S O O O
A A A M M M JN JL JL A A A S S S O O O
1993
MONTH
1994

Table 2. Number of shorebirds observed in each study site at the McPherson Valley Wetlands, in McPherson County, Kansas for the spring and fall seasons of 1993 and 1994 (expected number in parenthesis).

SEASON	BIG BASIN #2	CLEAR POND	KUBIN MARSHES	OTHER
SPRING	417(370.7)	164(105.8)	1(105.8)	80
FALL	348(248.4)	32(70.9)	10(70.9)	12

Figure 3. Water levels recorded at Big Basin #2 at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

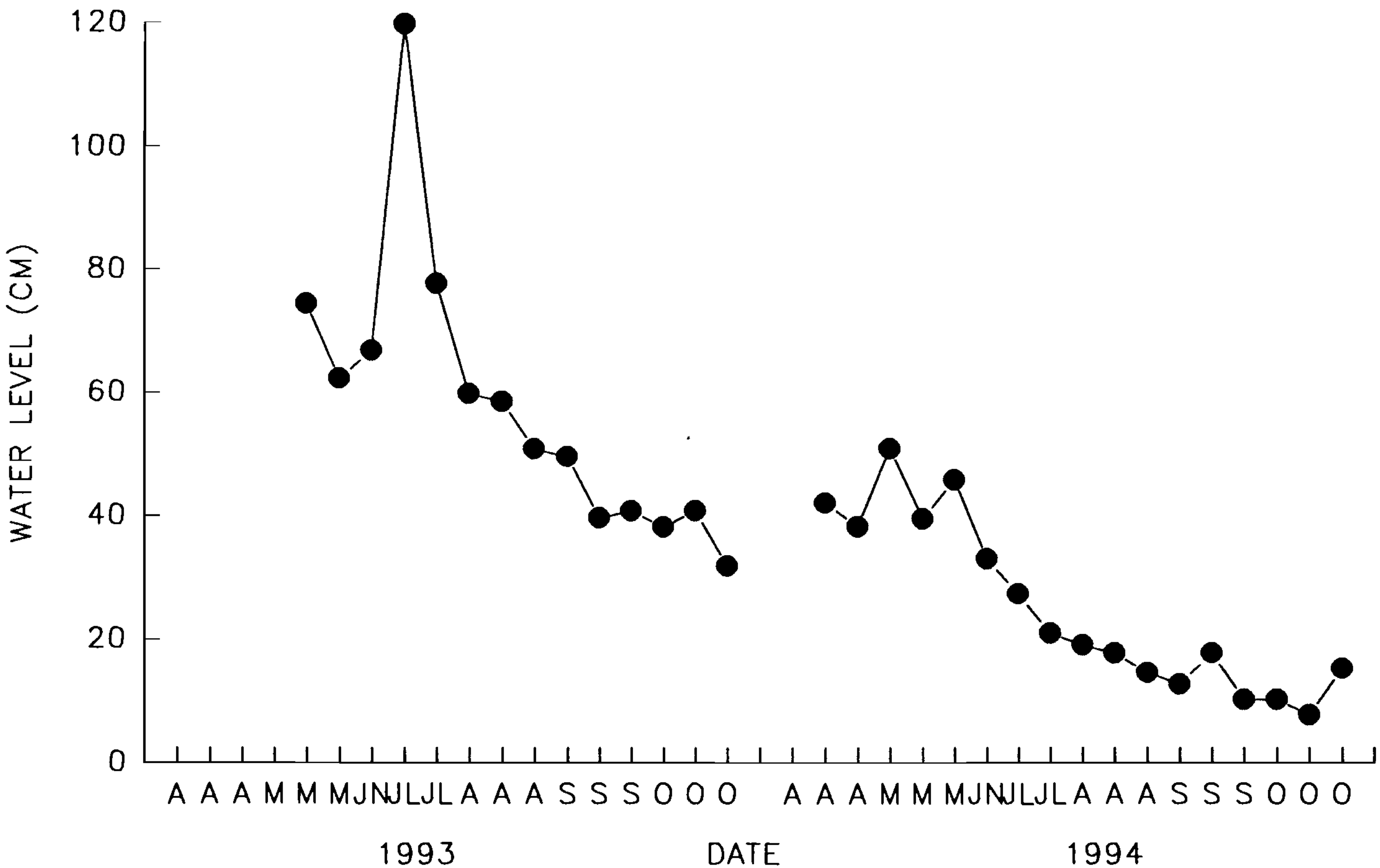
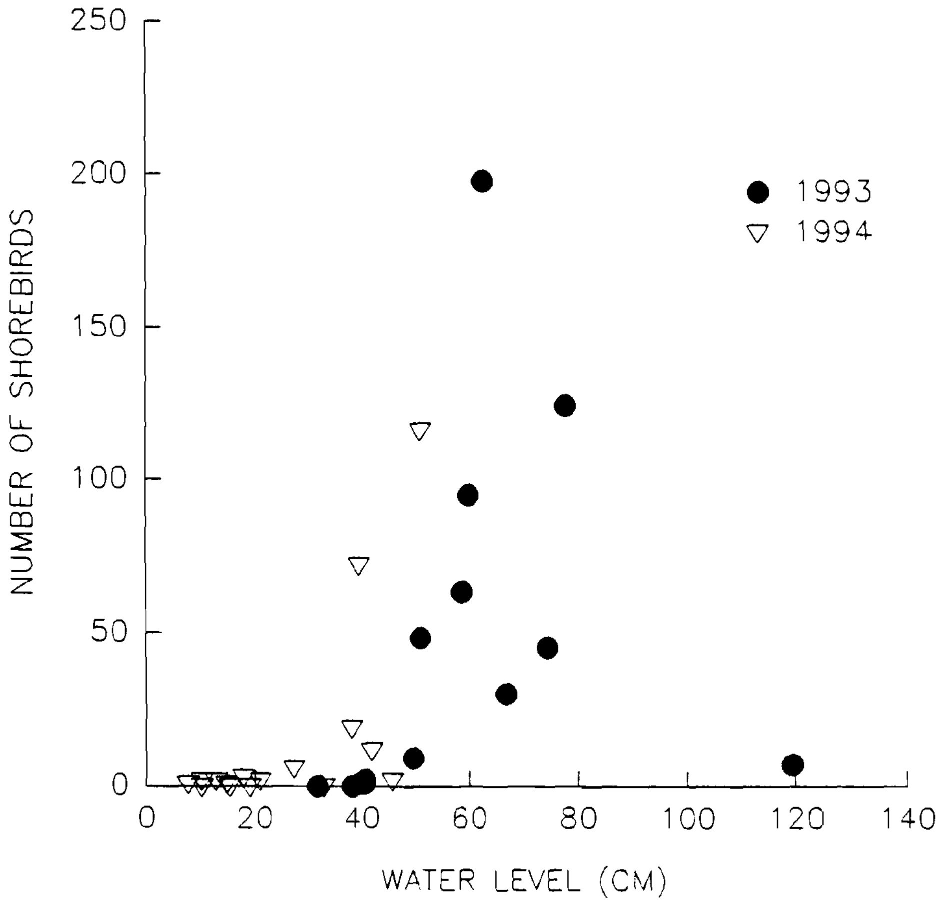

WATER LEVEL (CM)
0
20
40
60
80
100
120
A A A M M MJNJLJLA A A S S S O O O
1993
DATE
A A A M M MJNJLJLA A A S S S O O O
1994

Figure 4. Number of shorebirds versus water level at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

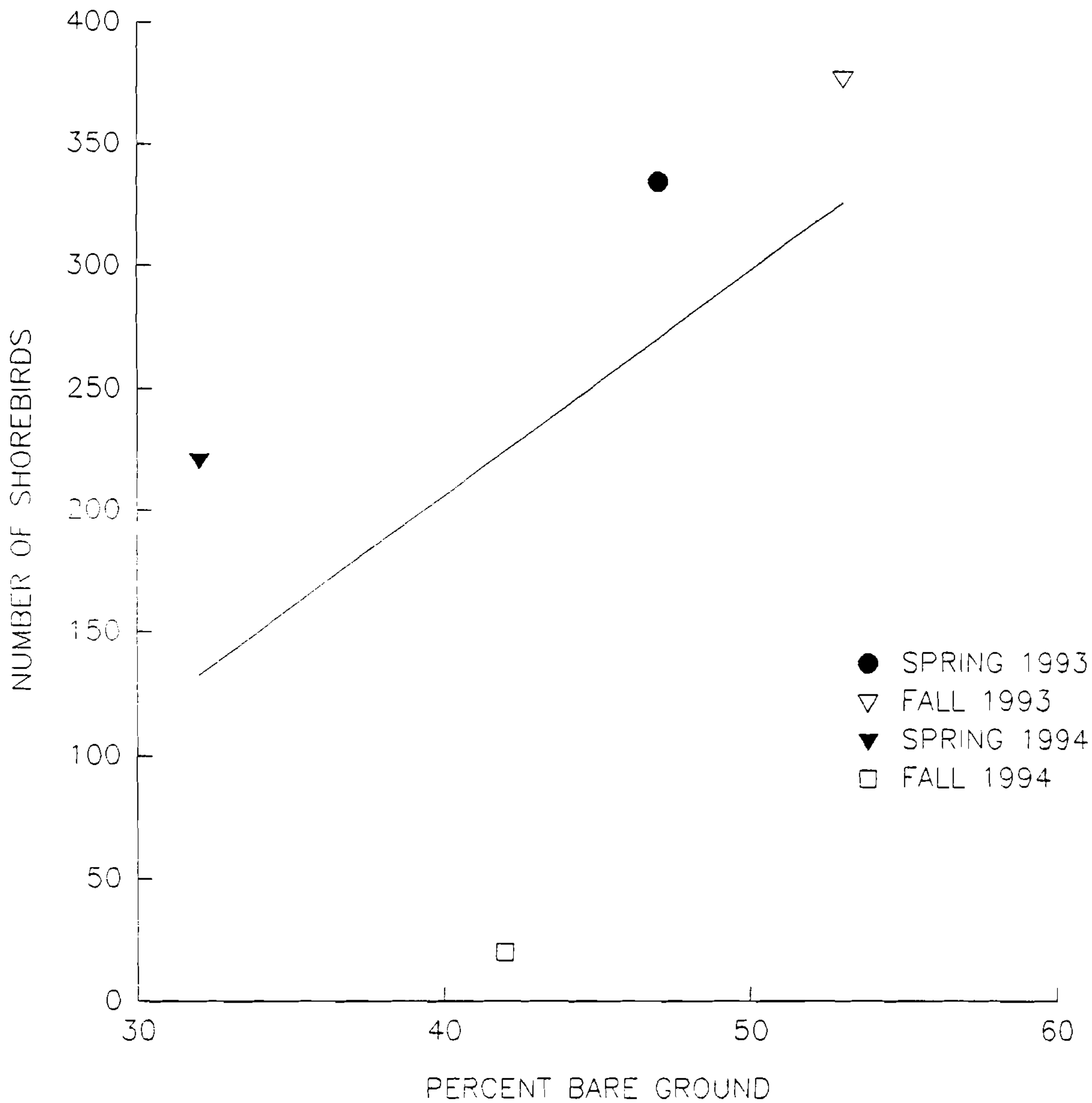


250
200
150
100
50
0
NUMBER OF SHOREBIRDS
1993
1994
0
20
40
60
80
100
120
140
WATER LEVEL (CM)

Table 3. Vegetation composition for the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

SEASON	% BARE	% LITTER	% VEGETATION
Spring 1993	47	53	.002
Fall 1993	53	35	12
Spring 1994	32	67	.002
Fall 1994	42	58	0

Figure 5. Number of shorebirds versus percent bare ground at the McPherson Valley Wetlands, in McPherson County, Kansas for each season, from spring 1993 through fall 1994.


400
350
300
250
200
150
100
50
0
NUMBER OF SHOREBIRDS
30
40
50
60
PERCENT BARE GROUND
SPRING 1993
FALL 1993
SPRING 1994
FALL 1994

DISCUSSION

This study shows that shorebirds do use the McPherson Valley Wetlands. Although the number of individuals was small, the number of species was fairly high. Approximately 36 species of shorebirds migrate through the Midwest (Helmers, 1992). During my study period, at least 20 species were observed although the extent of use was much less than that at Cheyenne Bottoms or QNWR. Those wetlands, in contrast to McPherson Valley Wetlands, have long been established as traditional stopover sites. If in fact traditional sites are more often used than opportunistic wetlands, then perhaps it will take a few years for shorebirds to start using the McPherson Valley Wetlands. If, on the other hand shorebirds are opportunistic in choosing migratory stopover areas, perhaps Cheyenne Bottoms and QNWR will need to have poor years before a large number of shorebirds will use the McPherson Valley Wetlands.

KDWP is just beginning its renovations of the area. In the future, when construction is done and management for shorebirds can take place, the area should be used by a larger number of birds.

My study shows the importance of shallow water to the area. A higher number of shorebirds was seen in 1993 than in 1994, most likely due to the higher water levels of 1993. During 1994, a dry year, shorebird numbers were significantly correlated with water levels. There appears to be a similar trend for 1993, but the extremely high water level for June may have affected the overall result. Too little water or too much water will reduce shorebird usage.

Water rights will need to be obtained for management of shorebirds. Because the Big Basin #2 is not fully owned by KDWP, management of water levels may be difficult, unless levees are built between public and private lands. Clear Pond and the Kubin Marshes, on the other hand, could have managed water levels. Perhaps water levels could be lowered in Clear Pond and a water control structure placed at the lower end of the ditch that runs through the Kubin Marshes. Water could then be slowed and allowed to spread out over what is now cropland.

A manager could either manage different pools for each type of wildlife or possibly impose some sort of moist soil management regime where both shorebirds and waterfowl would benefit (Fredrickson and Taylor, 1982). Possible management for the pools might include a slow drawdown during peak migration times to ensure food availability. In some wetlands, management of water levels would include allowing the site to go through natural cycles, that is, no direct water manipulations on the part of the manager.

In addition to water manipulation, vegetation would need to be managed. Shorebirds prefer sparse vegetation (Helmers, 1992). Vegetation and shorebird data from the McPherson Valley Wetlands showed a positive relationship between percent bare ground and number of shorebirds. Although this trend is not significant, it does correlate with Helmers' (1992) findings. Mowing, discing, grazing and burning are some management techniques used in reducing density of the vegetation.

Direct management of water levels would be difficult now, except for Clear Pond. Perhaps Clear Pond can be filled and drawndown to allow for maximum shorebird use. Water levels in the other sites may be left to nature. Vegetation density will most likely need to be managed. Discing, burning, and mowing are a few of the most viable options for this site.

Management of Big Basin #2 is critical because most shorebirds surveyed were seen in this site. A larger number of shorebirds was seen using the Big Basin #2 site. Although water levels can be manipulated very little now, perhaps a plan for managing vegetation could be started.

In addition to water levels, shorebird use of the area may have been related to peak migration times (Helmers, 1992). Large numbers of shorebirds migrate through Kansas in mid-late spring. Numbers drop off considerably in the summer when birds are breeding in the north. Large numbers of shorebirds move through Kansas in early-mid fall, but numbers generally taper off in late fall. So, shorebird numbers observed may not only correlate with water levels, but with times of peak migration as well. Water level management should be aimed at these peak migration times to ensure maximum shorebird usage.

Because the area is not yet managed for shorebirds, shorebird use of the area in the future is uncertain. It does seem, however, that when there is a small amount of water, shorebirds will use the area. It would be advantageous to continue censusing shorebirds in the future. It may take more than two years to establish an adequate pattern of use. The weather for 1993 and 1994 was odd, so more years may soften the extremes of these two years. Once all water control structures are in place and the area can have managed water levels, it will be important to see how and if, shorebirds use the area.

In addition to shorebirds, a large number of waders, gulls and terns were observed using the area. Managers may want to incorporate other birds into their management scheme as well.

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APPENDICES

Appendix 1. Number of waders, gulls and terns seen per season at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

SPECIES	SPRING 1993	FALL 1993	SPRING 1994	FALL 1994	TOTAL
Little Blue Heron	0	351	0	0	351
Great Blue Heron	17	74	5	4	100
Great Egret	30	40	0	0	70
Franklin's Gull	57	0	5	0	62
Snowy Egret	0	43	0	0	43
White-faced Ibis	0	24	6	0	30
Black Tern	14	5	0	0	19
Black-crowned Night Heron	0	10	0	0	10
American Bittern	1	4	0	0	5
Cattle Egret	1	0	0	0	1
Ring-billed Gull	0	0	1	0	1
TOTAL	120	551	17	4	692

Appendix 2. Scientific names for birds seen at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through 1994 (American Ornithologist's Union, 1983).

SCIENTIFIC NAME	COMMON NAME
Ciconiiformes	
Ardeidae	
Botaurus lentiginosus	American Bittern
Ardea herodias	Great Blue Heron
Casmerodius albus	Great Egret
Egretta thula	Snowy Egret
Egretta caerulea	Little Blue Heron
Bubulcus ibis	Cattle Egret
Nycticorax nycticorax	Black-crowned Night Heron
Threskiornithidae	
Plegadis chihi	White-faced Ibis
Charadriiformes	
Charadriidae	
Charadrius vociferus	Killdeer
Recurvirostridae	
Recurvirostra americana	American Avocet
Scolopacidae	
Tringa melanoleuca	Greater Yellowlegs
Tringa flavipes	Lesser Yellowlegs
Catoptrophorus semipalmatus	Willet
Actitis macularia	Spotted Sandpiper
Bartramia longicauda	Upland Sandpiper
Numenius americanus	Long-billed Curlew
Limosa haemastica	Hudsonian Godwit
Calidris pusilla	Semipalmated Sandpiper
Calidris mauri	Western Sandpiper
Calidris minutilla	Least Sandpiper
Calidris bairdii	Baird's Sandpiper
Calidris melanotos	Pectoral Sandpiper
Calidris alpina	Dunlin
Calidris himantopus	Stilt Sandpiper
Limnodromus griseus	Short-billed Dowitcher
Limnodromus scolopaceus	Long-billed Dowitcher
Gallinago gallinago	Common Snipe
Phalaropus tricolor	Wilson's Phalarope
Laridae	
Larus pipixcan	Franklin's Gull
Larus delawarensis	Ring-billed Gull
Chlidonias niger	Black Tern

Appendix 3. Plants found at the McPherson Valley Wetlands, in McPherson County, Kansas from spring 1993 through fall 1994.

COMMON NAME	FAMILY	GENUS
Water Plantain	Alismataceae	_Alisma_
Aster	Asteraceae	_Aster_
Bur Ragweed	Asteraceae	_Ambrosia_
Tickseed	Asteraceae	_Coreopsis_
Wallflower	Brassicaceae	_Erysimum_
Yellowcress	Brassicaceae	_Rorippa_
Spikerush	Cyperaceae	_Eleocharis_
Toothcup	Lythraceae	_Ammania_
Sorrel	Oxalidaceae	_Oxalis_
Dropseed	Poaceae	_Sporobolis_
Annual Brome	Poaceae	_Bromus_
Perennial Brome	Poaceae	_Bromus_
Foxtail Barley	Poaceae	_Hordeum_
Barnyard Grass	Poaceae	_Echinochloa_
Foxtail	Poaceae	_Setaria_
Smartweed	Polygonaceae	_Polygonum_
Forb		
Standing Dead Forb		
Grass		
Standing Dead Grass		

Kristen J. Mitchell

Signature of Graduate Student

Signature of Major Advisor

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